T371
.K4

T371
.K4

MECHANICAL DRAWING

LETTERING, MATERIALS AND METHODS

BY FRANK R. KEPLER
Cass Technical High School Drafting Department

Published under Authority of
THE BOARD OF EDUCATION
Detroit, Michigan

T371
.K4

Copyright 1916
by
FRANK R. KEPLER

Printed in
Cass Technical High School
Detroit, Michigan

T371
.K4

MECHANICAL DRAWING

F. R. Kepler

INTRODUCTION

Broadly speaking, Mechanical Drawing may be understood to mean drawing done with the aid of instruments. More strictly, it may mean the drawing of machines or things mechanical as distinguished from architectural drawing, for instance. Mechanical drawings of machines are often called working drawings, of buildings they are called plans. Such drawings convey the ideas of the originator or engineer to the mechanic or the workman. Mechanical drawing, then, may be said to be the language of the engineer, the architect, the mechanic. The musician conveys his ideas by means of music, the artist by means of his picture.

An inventor or designer often spends weeks and months on some contrivance or plan. He probably makes many calculations. It would be almost impossible for him to remember all the details and scores of dimensions, much less to tell them to some one else. The drawing then furnishes him with a means of recording his ideas and calculations and showing details of construction.

The requirements of a good draftsman are neatness, accuracy and rapidity. By neatness is meant that not only must the draftsman keep his drawing clean, but he must arrange it neatly. The student must cultivate the habit of making clean, sharp lines and neat, well-arranged drawings. Unless a drawing is made in a workmanlike manner, the work on the contrivance is not apt to be performed in a thorough manner.

Accuracy, too, is most important. It is evident that unless a drawing is made accurate in detail and dimensioned accurately, work made from it will not be as planned. It will often be found impossible to make the thing at all or costly mistakes will result. Much valuable time, labor, and material will be wasted because of a careless draftsman and checker.

A draftsman should not only be neat and absolutely accurate, but he must be able to make a drawing in a reasonable length of time. No matter how good a draftsman may be, an employer can hardly afford to keep him unless he has a certain degree of rapidity. However, accuracy and neatness should not be sacrificed for rapidity. Rapidity greatly depends on how one takes hold of a piece of work, his order of procedure. A regular order should be acquired.

The beginner taking up the study of mechanical drawing for the first time must of necessity learn the names and uses of the instruments and tools employed. We may say that the tools of the draftsman do not necessarily mean the special drawing instruments alone, but include a working knowledge of conventional lines and standards and a ready skill in making well formed letters. Proficiency in lettering is most essential to a draftsman. Therefore, a careful study will be made of one form of lettering and considerable practice given not only in lettering but in the use of mechanical drawing instruments and materials.

JUL -5 1916
0.25
©Cl. A 433607

LETTERING

F. R. Kepler

The subject of lettering is of great importance to the mechanical draftsman. Many well executed drawings have been disfigured by poor lettering.

Every draftsman must be able to letter a drawing neatly and rapidly. Any system of letters suitable for working drawings must not only be neat in appearance but well proportioned. Artistic finish is secondary to plainness and speed. A simple form is necessary; first, that dimensions and notes may be so easily read by the workman that he may have no excuse for committing a blunder; second, that the letters may be easily and rapidly made in order to keep the cost of the drawing low. While artistic lettering requires a particular aptitude and a natural fitness for the work, a simple style is within the reach of any draftsman, and ignorance upon this important subject is inexcusable.

Since it is the almost universal practice to use only capital letters upon working drawings and owing to the limited time at the disposal of the student, attention at first should be given to the making of capitals only. It is evident that in the time allowed much better results can be obtained through practice upon but one form of letter.

A common fault with a beginner is to leave too little space between the words and too great space between the letters composing the words. The beginner must copy from good models all the different kinds of characters and thus acquire a perfect knowledge of the proper proportions of every letter. Proficiency can be acquired only by practice.

As tracings are made of most drawings and blue prints are made from these, it is necessary that the corners of the letters be made sharp and clean; the curves round and full so that they will not fill in when inked. The bold lines should be made freely. The use of waterproof ink necessitates wiping off the pen frequently and working the points between the fingers to loosen the dry ink.

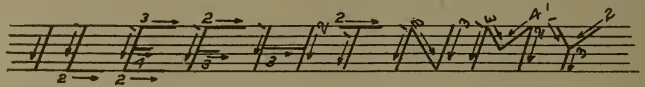
Various systems of simple letters are in use. The main requirement of any system is that good execution and a fair degree of rapidity be easily acquired. In the system employed in this course, only two elements are used; namely, the straight line and the ellipse. The letters are five (5) spaces high, being inclined

two (2) spaces to the right, making the inclination about 22½ deg. from the perpendicular.

As this system of lettering is designed for use in connection with working drawings and blue printing, the formation of the letters is determined largely by that fact and that it is often necessary to make them in ink with a pen. Experience has proven that most letters are most successfully made by employing two or more strokes downward. The letters must all appear broad. Bear in mind that the letters must be made with care, drawn, if you please, rather than printed. Remember that the spirit of a mechanical drawing is precision, accuracy. The lettering must bear out this feeling and at the same time be well proportioned in design.

LETTERS

To aid the beginner, a detailed description will be made of each letter. Upon examination we find that the letters are divided into groups, those made up of straight lines only, including those formed of the inclined stroke and the horizontal stroke; those made of the ellipse or a modification of it; and those made by a combination of the straight line and the ellipse.



The letters I, L, F, E, H, and T compose the first group. The capital I consists of a simple inclined stroke. It is never dotted. If it stands alone or would otherwise be confusing, horizontal strokes are often made across the top and bottom. L should be made by making the slanting stroke down and then the horizontal stroke to the right. The length of this stroke is four-fifths (4/5) of the height. F is made with the inclined stroke first, then the horizontal stroke at the top is made four-fifths (4/5) of the height and the third, horizontal stroke, just a little below the center, is one-half as long as the height of the letter. The E is begun just as the letter L is made and then the upper and middle horizontal strokes are made just as in the letter F. However, the short stroke is made a little above the center in order to give a sense of stability to the letter. Do not make the last stroke too long.

H consists of two inclined parallel strokes a little more than four spaces apart making the width of the letter a trifle better than four-fifths (4/5) of its height, a horizontal stroke just a little

above the center completes the letter. Care should be taken to make this stroke straight across. The inclined stroke of the T is made first, and then the horizontal stroke at the top from left to right, being careful to make it perfectly horizontal. This stroke is made four and a half (4½) spaces long, two and a half (2½) spaces being at the left.

N, M, Y, X, A, K, V, W, and Z compose the group made up of inclined and diagonal strokes. The N, like the H, must be made four (4) spaces wide. The inclined stroke on the left is made first, then the diagonal stroke from the top downward, being sure that it is inclined two spaces at least. The last stroke on the right is made downward and parallel to the first. To insure making a good M, it is necessary to make the two inclined strokes at the

left and right first. They are made parallel and five (5) spaces apart, the letter being of the same width as the height. The two diagonal strokes are made to meet at the center by drawing the lines as if they continued across the letter from corner to corner.

The Y is more readily made by making first the inclined stroke at the top and left at the same slant to the left as the stem of the letter is to the right. Second, make the stroke at the right downward, starting at a point four and a half (4½) spaces to the left and meeting the first just half way down the height of the letter. Third, make the stem of the Y downward inclined like the I. Great care must be taken not to make the letter too narrow nor the last two strokes too nearly in the same straight line. To made the X properly, make the stroke from the right downward, bringing it six (6) spaces to the left. The second stroke begins four and a half (4½) spaces to the left and is inclined about 60 degrees. When completed, lines drawn at either side would be inclined two (2) spaces, the whole letter having the proper inclination.

In making an A, which is as broad as it is high, make the stroke on the left first downward at an angle of 45 degrees, nearly. Make the stroke on the right downward so that it slants outward a half of a space. In a small-sized letter, this stroke may be made vertical. The horizontal stroke must be made perfectly horizontal well below the center, a space and a half above the bottom. The K is four spaces wide. First, the inclined stroke at the left is made just as an I, the second begins four (4) spaces to the right of the first at the top and joins the first two (2) spaces above the bottom of the letter; the third stroke is made downward from the second three (3) spaces above the bottom to a point four (4) spaces to the right of the lower end of the first.

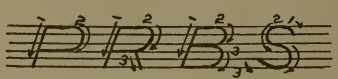
V and W are very similar. The top of the first stroke at the left inclines a half space to the left. The second stroke begins four and a half (4½) spaces to the right and is made downward to meet the first. W is made very similarly except that the parts are slightly narrower, being four spaces wide. In a small-sized letter, the first stroke may well be made vertical. In the Z, make the upper horizontal stroke first, then the diagonal stroke downward to the left six (6) spaces to the left of the upper end. Make the first stroke four and a half (4½) spaces long, the last five (5) spaces.

O, Q, C, and G form a most important group. All are five (5) spaces wide, as broad as they are high. All are elliptical, the axes being at 45 degrees. Beginning at the top, form the left hand side

of the ellipse, being careful to make the curve full and smooth. In like manner, beginning at the top, form the right hand half. The Q is formed in exactly the same manner with the addition of the inclined stroke at the bottom. A letter C can best be formed by starting a short stroke downward from the top towards the right. Then with one stroke form the left half of the letter, continuing on up into the lower right hand portion of the letter, making it end rather straight, one and a half spaces from the bottom. The G is made in just the same manner as the C, with the horizontal stroke a space and a half long. This last stroke must not extend outside the letter.

The letter D is composed of a combination of straight lines and a portion of the ellipse. The inclined stroke is first made, then beginning at the top bring the line out horizontally two and a half spaces, form the right half of the ellipse and finish by continuing horizontally to the lower end of the inclined stroke. The letter should be made fully four and a half (4½) spaces wide.

U and J are made very similarly. Make the two sides of the U parallel and four and a half (4½) spaces apart first. Bring these down a trifle more than half the height. Form the lower



portion, which is the lower half of an ellipse, beginning at the left. Be careful to make the lines join nicely. In the J draw the inclined stroke continuing into about half of the curve. Finish the letter by beginning at the left, joining the curve nicely.

P, R, and B may be grouped in one class. These are made up of straight lines and smaller ellipses. With P, make the inclined stroke first, begin at the top, start out horizontally for about two (2) spaces form the right half of an ellipse and bring the lower

line straight and horizontally to the inclined stroke three (3) spaces wide. R is made just as the letter P is made. The additional stroke is made straight and as if it started a space to the right of the upper left hand corner and continued to a point making the letter five (5) spaces wide at the bottom. The first strokes of B are made as in P and R, although not quite so wide and join the inclined stroke a little above the center. The lower portion is made broader and higher. This form gives a sense of stability to the letter.

The letter S, as indicated, is composed of the portions of two small ellipses with the axes extending horizontally. It should be formed by making the stroke from the top towards the right as in C and G. Beginning at the top, again draw the left half of the upper stroke. Finally add a downward stroke. The first and last strokes are often all that are needed to give the appearance of the proper inclination. Care must be taken to make the stroke at the center of the letter horizontal. The lower portion of the letter is often made higher than the upper, with very satisfactory results. This letter requires much practice.

FIGURES

Figures are perhaps the most important division of lettering. It is absolutely necessary that all figures shall be made plain. No doubt should be left as to just what the figure is. Especial attention is therefore required for this branch of the subject.

The 8 is quite similar in formation to the letter S. It is composed of two ellipses, one above the other, the axes being horizontal. By making the upper ellipse slightly narrower and less in height than the lower, a more pleasing figure is secured. There are four strokes, one to the right at the top, one to the left, one at the bottom and the last to the right at the bottom completing the figure. Join the portions carefully.

3 is very easily formed, bearing in mind that the upper and lower portions are parts of ellipses. It is best formed by beginning at the top, bringing the curve well over to the right and without removing the pencil, form the lower curve.

For the 2, start at the top, forming the loop smoothly and a little less in height than half the height of the figure. Continue

into the reverse curve, bringing it pretty square to the bottom, and add the horizontal stroke four spaces long. This is a pleasing figure only when well formed. Do not make the lower part too low and sharp.

The 9 should be made four (4) spaces wide. The upper portion is a small ellipse fully three and one-half spaces high. The left half is made as for an O, the right half formed, and, beginning well toward the top, complete the figure by forming the right and lower half of a large ellipse. Care must be taken to make the upper portion of sufficient height. Do not make it straight on the right.

A 6 is formed first as if for the letter C and then, beginning at a point three-fifths (3/5) of the way down on the left, complete the small ellipse forming the lower portion of the figure. The lower portion is two-thirds (2/3) the entire height.

In a 5, first make the inclined stroke, then form the body of the figure by making a portion of a full ellipse at least two-thirds (2/3) the height of the letter. Finally add the horizontal stroke at the top, three and a half spaces long. In making the figure, care must be taken to bring the elliptical part to its proper height above the lower end of the inclined stroke.

Make the diagonal stroke of the 4 at 45 degrees, the horizontal stroke five and a half (5½) spaces long, and third the inclined stroke. Be sure to make the horizontal stroke of the figure a space and a half (1½) above the base. This figure is commonly made too narrow.

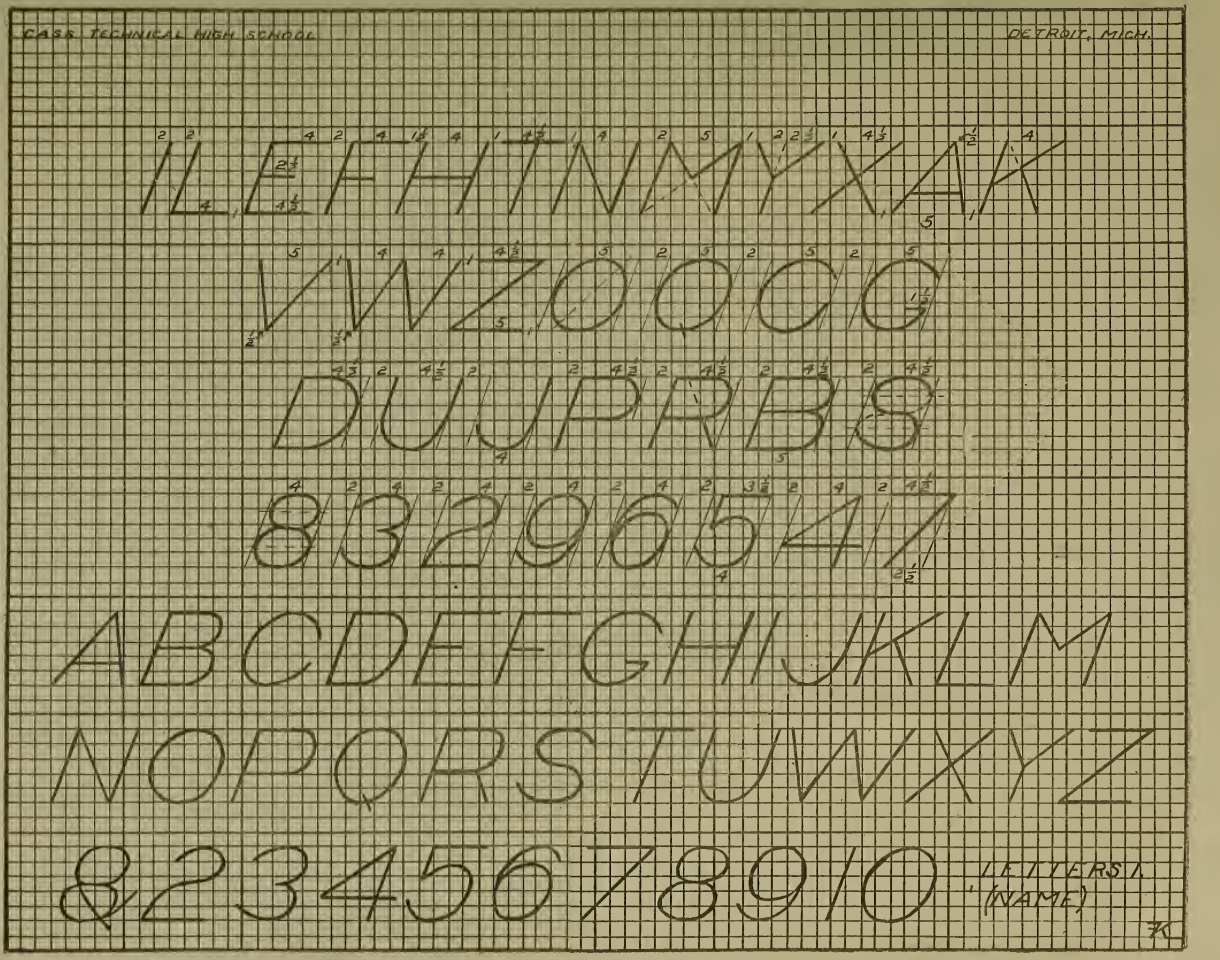
In the figure 7, the horizontal stroke is made four and a half (4½) spaces long, and the diagonal stroke at 45 degrees is brought to a point at the bottom a space to the left of the starting point of the letter.

EXERCISES

The exercises and plates which follow are for drill and practice. Observe and study the formation of each character. Too great care cannot be taken in making each just right. Follow the directions to the letter.

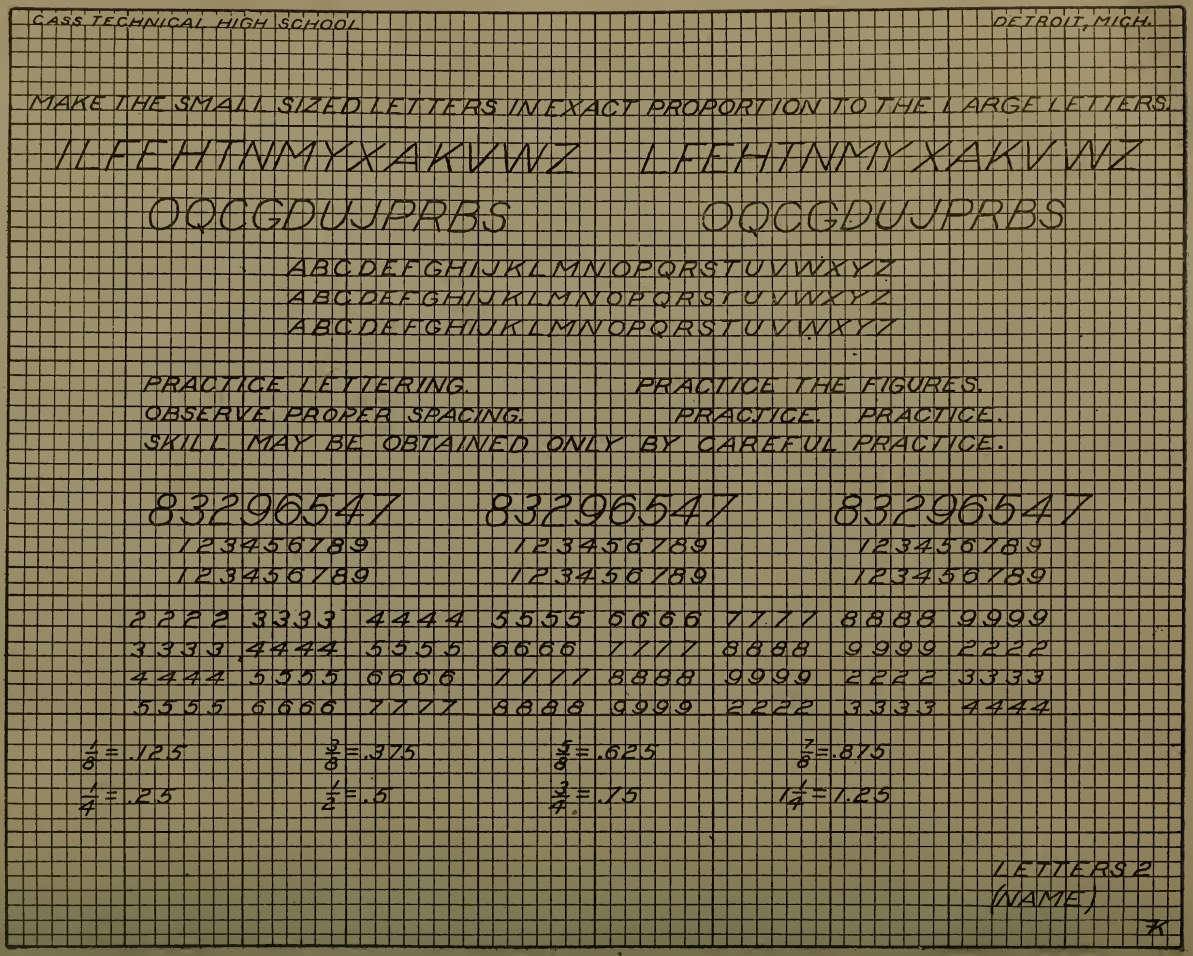
Letters 1

Make an exact copy of "Letters 1" on the co-ordinate paper provided for the purpose. The letters are to be made entirely free-hand, in pencil only. The light guide lines must be made for all the letters as shown. The small figures indicate the number of spaces. Make clean sharp lines. Avoid erasing as much as possible. A 3-H pencil, sharpened to a cone point, will give best results. The name of the student is to be lettered where the word "Name" appears in parenthesis.



Letters 2

Read carefully in the text the description of the manner of forming the individual letters. Take pains to form the habit of making the letters as described At the top of the sheet, omit the words, "Make small letters in exact proportion to the large letters." Do not fail to put the caution into practice, however. Copy "Letters 2" on the ruled sheet in pencil first Great care should be taken with the figures. After submitting it to your instructor, with approval, it may be inked with the Gillott pen — 404.


CASS TECHNICAL HIGH SCHOOL
DETROIT, MICH.
MAKE THE SMALL SIZED LETTERS IN EXACT PROPORTION TO THE LARGE LETTERS.
ILFEHTNMYXAKVWZ LFEHTNMYXAKVWZ
OQCGDUJPRBS OQCGDUJPRBS
ABCDEFGHIJKLMNOPQRSTUVWXYZ
ABCDEFGHIJKLMNOPQRSTUVWXYZ
ABCDEFGHIJKLMNOPQRSTUVWXYZ
PRACTICE LETTERING.
OBSERVE PROPER SPACING.
SKILL MAY BE OBTAINED ONLY BY CAREFUL PRACTICE.
PRACTICE THE FIGURES.
PRACTICE. PRACTICE.
83296547 83296547 83296547
1234567890 1234567890 1234567890
1234567890 1234567890 1234567890
2222 3333 4444 5555 6666 7777 8888 9999
3333 4444 5555 6666 7777 8888 9999 2222
4444 5555 6666 7777 8888 9999 2222 3333
5555 6666 7777 8888 9999 2222 3333 4444
1/8 = .125 3/8 = .375 5/8 = .625 7/8 = .875
1/4 = .25 1/2 = .5 3/4 = .75 1 1/4 = 1.25
LETTERS 2
(NAME)
7

Letters 3.
Copy the first two sentences of "Letters 3" on a ruled sheet with a pencil. Take care to have the letters properly grouped into words and sufficient space left between the words. Avoid any crowding of words together. Note that it is often desirable to make the initial letter of a sentence about one and one half times as high as the other letters. After penciling the first two sentences, submit them to the instructor and, with his approval, trace them in ink, and continue the remainder of the sheet directly in ink.

LETTERING

THE SUBJECT OF LETTERING IS OF GREAT IMPORTANCE TO THE MECHANICAL DRAFTSMAN. HE MUST BE ABLE TO LETTER A DRAWING NEATLY AND RAPIDLY A COMMON FAULT WITH A BEGINNER IS TO LEAVE TOO LITTLE SPACE BETWEEN THE WORDS AND TOO GREAT A SPACE BETWEEN THE LETTERS COMPOSING THE WORDS. THE BEGINNER MUST COPY FROM GOOD MODELS ALL THE DIFFERENT KINDS OF CHARACTERS AND THUS ACQUIRE A PERFECT KNOWLEDGE OF THE PROPER PROPORTIONS OF EVERY LETTER. PROFICIENCY CAN BE ACQUIRED ONLY BY PRACTICE.

CONVENTIONAL LINES.

1. VISIBLE EDGES AND OUTLINES OF OBJECTS SHALL BE REPRESENTED BY FULL, MEDIUM LINES.

2. HIDDEN EDGES OF OBJECTS SHALL BE REPRESENTED BY BROKEN LINES, CONSISTING OF SHORT $\frac{1}{8}$" DASHES, SOMEWHAT LIGHTER THAN MEDIUM LINES, SEPARATED BY $\frac{1}{16}$" SPACES.

3. DIMENSION LINES SHALL BE FINE, SOLID LINES, INTERRUPTED FOR THE FIGURES EXPRESSING THE DIMENSION AND TERMINATED BY LONG NARROW ARROW-HEADS; AND DRAWN AT LEAST $\frac{1}{4}$" FROM THE OBJECT.

4. REFERENCE LINES SHALL BE FINE, FULL LINES DRAWN AT RIGHT ANGLES TO THE EDGE MEASURED, FROM A POINT $\frac{1}{32}$" FROM THE EDGE, AND PROJECTING $\frac{1}{16}$" BEYOND THE ARROW-HEAD.

5. CENTER LINES SHALL BE FINE, BROKEN LINES CONSISTING OF LONG, $\frac{5}{8}$" DASHES, SEPARATED BY SINGLE $\frac{1}{16}$" DOTS AND SPACES

6. PROJECTION OR CONSTRUCTION LINES, INCLUDING ALL LINES NOT ESSENTIAL OUTLINES OR EDGES OF THE OBJECT, SHALL BE FINE $\frac{1}{16}$" DOTTED LINES. THESE ARE SELDOM INKED

LETTERS 3.
(NAME)

ABCDEFGHIJKLM
NOPQRSTUVWXYZ.
1234567890
TITLES OF ALL DRAWINGS SHALL BE 1/4 HIGH
SUB TITLES OF ALL DRAWINGS SHALL BE 1/8 HIGH
All Notes Shall Be 1/8" High
abcdefghijklmnopqrstuvwxyz.
Good printing can be acquired by any one, providing he will spend the time necessary to gain a thorough knowledge of the form, proportion and spacing of each letter. Speed can be attained only through constant practice.
While architectural lettering is more or less decorative, it should not be carried so far that it may not be easily read. The above title alphabet is easily mastered, because it is composed of the straight line and circle, or arc of a circle.
CASS TECHNICAL HIGH SCHOOL
I.G.K.

ARCHITECTURAL LETTERING

I. G. Koehler

As architectural drawing is more decorative and artistic than mechanical, so architectural lettering must also lean toward the decorative and artistic, to be in harmony with the drawing.

Both slant and vertical lettering are used; each having its advantage and disadvantage. The slant type is adapted to speed and medium class of work, the vertical to a more decorated and higher class of work. As will be noticed on the copy, the letter is composed of the straight line and the circle, making it a very simple and effective style of lettering. Students will be held to this one style of letter for the first term only, when they will begin to pick up letters of their own and which will finally lead to the student having an alphabet showing individuality. In no case, however, should a single letter be so far away from the accepted form that it would not be recognized without the companion letters at its side.

Architectural lettering is made up of letters showing extremes, for instance the middle bar of the B, F, H, F, or S is placed very high or the lower bar of an R, P, 4, etc., placed very low. This style of lettering can be accomplished by a basic knowledge of mechanical lettering, copying good letters, and a great deal of practice.

The lower case is used chiefly for notes and should correspond in slant to that of the titles and sub-titles. The secret of good lower case lettering is in making extremely full curves and straight lines of the same slant. Finally, regarding all printing, the student should have a thorough knowledge of good spacing.

DRAWING INSTRUMENTS AND MATERIAL

F. R. Kepler

Drawing Board:—The drawing board should be made of some soft wood, such as pine, to allow the thumb tacks to be pressed in readily. The board must be so constructed as to prevent warping. The ends must be perfectly straight so as to give a good bearing for the head of the T-square.

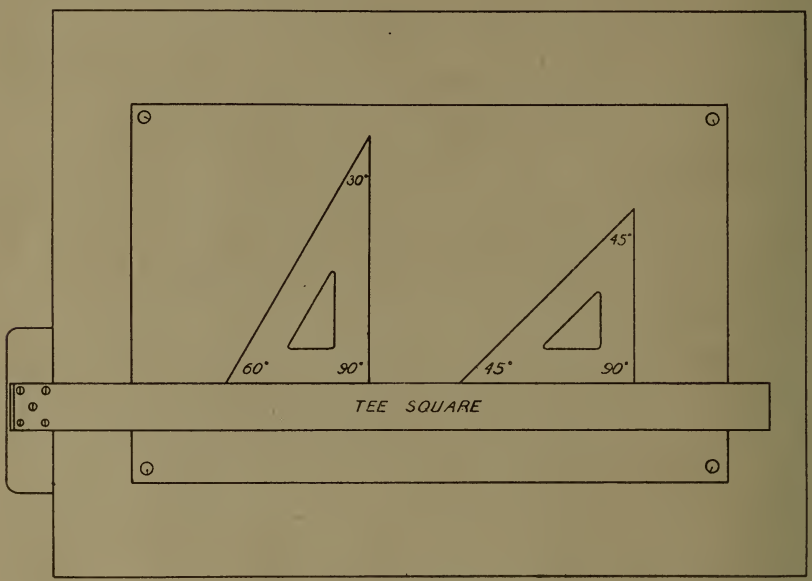


Figure 1

To fasten the paper to the board:—Adjust the paper in its proper position, put a thumb tack in one of the upper corners. Be sure to press it clear down to the head. Stretch the paper diagonally to the lower corner and insert a second thumb-tack. Then stretch the paper from the center toward the two remaining corners and fasten with thumb-tacks. In this way the paper may be made to lie perfectly smooth on the board. Fig. 1.

The Pencil:—Pencils are graded according to the degree of hardness. H denotes a soft pencil, a 3-H or 4-H being medium hard, while a 6-H is very hard. There are several grades from H to 8-H. For general use the pencil should be sharpened to a long

cone point. About a quarter of an inch of the lead should be exposed and this ground down to a fine point on a piece of sand paper. Accurate work depends largely on the sharpness of the pencil point. Fig. 2.

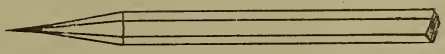


Figure 2

Penciling:—The pencil must be held lightly between the fingers, about three inches from the end, to insure a light line. The line should be distinct, but great care is necessary in order to avoid bearing on too hard and thus creasing the paper. It is impossible to erase such lines satisfactorily; the creases are most sure to remain to disfigure the drawing and make it difficult to ink. The penciled drawing should be made with great care. Accuracy must be practiced not only in order to attain accuracy but it is the custom at present to trace the penciled drawing on tracing paper or cloth prepared for the purpose. This tracing is often done by another person other than the one who has made the drawing. Therefore, it is evident that every line must be in its proper form, size, position and relation to every other line, so that the tracer may have the drawing accurate. Make it a practice to make all the corrections in pencil before inking or tracing, otherwise costly blunders are sure to result.

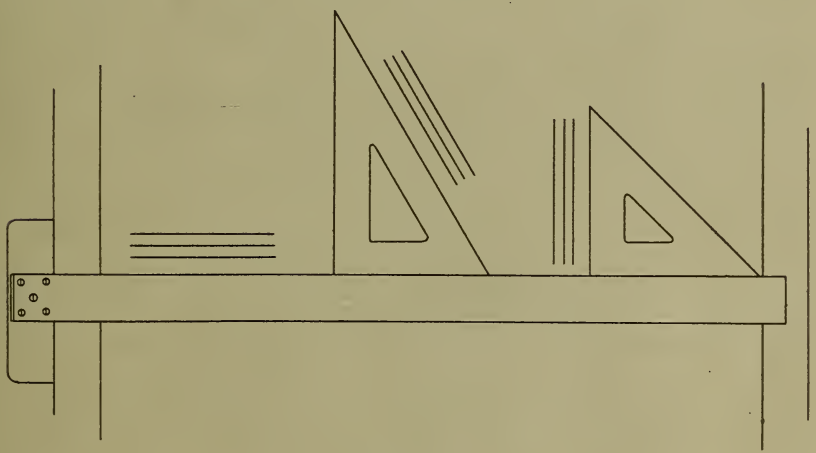


Figure 3

T-square:—The T-square is composed of the head and the blade, generally fitted at right angles to each other. The head is the short, heavier piece, while the blade is the long, thin piece having a perfectly straight edge. It is customary to place the head against the left-hand edge of the board so that the blade extends across the board. Horizontal lines are drawn, using the

upper edge of the T-square as a guide. Fig. 3. The upper edge of the T-square is also used for placing the triangles against to draw vertical lines and lines at an angle.

Triangles:—Fig. 1. Two triangles are ordinarily used. One has a right angle, or 90 degree angle, and two 45 degree angles. Two of its sides are equal. The other triangle has a 90 degree, a 30 degree, and a 60 degree angle. None of its sides are equal. By using the 90 degree angle of either triangle against the T-square, vertical lines or lines perpendicular to the edge of the T-square, may be drawn. Fig. 3. By placing the triangles so that one of the other angles comes against the upper edge of the square, lines at 45, 30, and 60 degrees may be drawn. By properly adjusting the two triangles, lines may be drawn parallel with any line, even though it is not at 45, 30, or 60 degrees. Fig. 4.

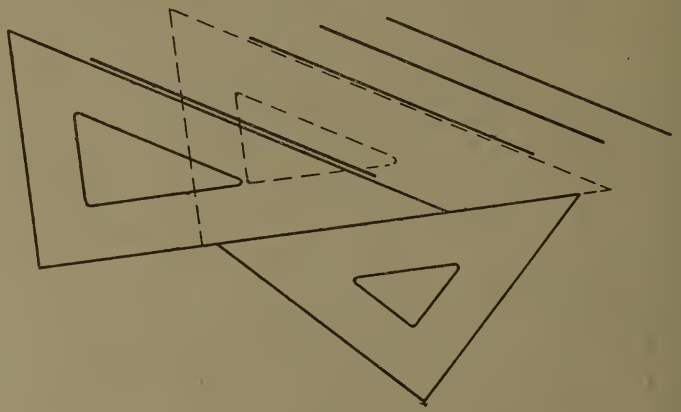


Figure 4

An angle is formed by the meeting of two lines. Angles are measured by degrees. If we consider that the line oa, Fig. 7, has been revolved about the point o as a center until it has made one complete revolution, we say that it has revolved through 360 degrees, a degree being one-three hundred sixtieth, 1/360, of a complete revolution. Degrees are indicated by the character, ° . Again, if the line oa is revolved half way around, a is at b, and the line ob forms a straight line with oa. The line oa, then, has revolved through 180/360 of a complete revolution, or 180°. An angle of 180 degrees is formed. If the line oa be revolved from its original position through one-fourth (¼) of a complete revolution to the position oc, it has been revolved 90/360 of a revolution, or 90°. Thus an angle of 90 degrees is formed. This is called a right angle. Also if the line be revolved through one-eighth of a complete revolution to the position od, it has been revolved through 45/360 of a revolution, or 45°, and an angle of 45 degrees is formed.

In Fig. 8, if the line oe be revolved through one-sixth of a revolution, it has been revolved through 60/360, or 60°, and an angle of 60 degrees is formed. If the line be revolved to f, one-twelfth of a revolution, it has been revolved 30/360, or 30°, consequently an angle of 30 degrees is formed.

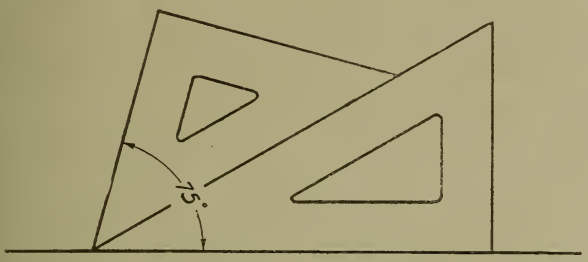


Figure 5

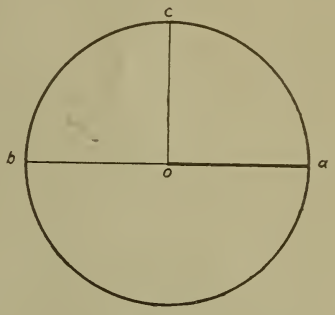


Figure 7

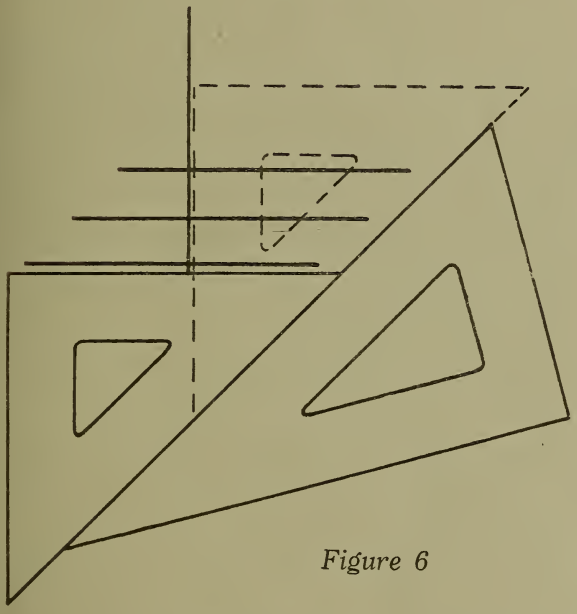


Figure 6

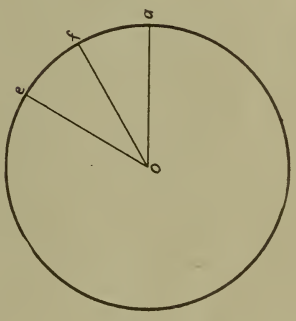


Figure 8

On examination of Fig. 7, it is evident that the sum of all the angles about a point on the same side of a straight line is equal to 180°, or two right angles. How many 60° angles about a point on the same side of a straight line? How many 30° angles?

How many 45° angles in a right angle? How many 45° angles about a point on the same side of straight line? What angle added to a 60° angle will make an angle of 90°? A 45° angle added to a 30° angle makes an angle of how many degrees?

Scales:—Draftsmen use either an architect's scale or an engineer's scale. These scales are often made triangular in shape. One edge has the inches divided into halves, quarters, eighths and sixteenths—other edges have scales three inches to the foot, 1½ inches to the foot, 2 inches to the foot, 1 inch to the foot, and so on as low as 3/32 inch to the foot. On the engineer's scale the inch is divided into tenths, twentieths, thirtieths, fortieths, fiftieths and sixtieths. Scales are also made flat and in three and six inch lengths.

The scale is used to measure off distances on the drawing. The zero mark should be placed at the ponit to be measured from, the desired distance determined and a light line made at right angles with the edge. Never turn the pencil in the fingers because that makes an ugly hole in the paper which cannot be erased. When several distances are to be measured off along the same line, place the zero mark at the proper point measure off the first distance, then proceed to measure off the second and third without moving the scale from its original position. This method secures greater accuracy. Never use the scale for a straight edge. Never mark distances on a scale with a pencil.

Drawings are made ¼″, ½″, ¾″, 1″, 1½″, 2″, 3″, 4″, 6″, 9″ and 12″ to the foot. A drawing made 1″ to the foot is 1/12 actual size; 3″ to the foot, ¼″ actual size.

TABLE OF SCALES

Scale per foot	Size	Scale per inch	Scale per foot	Size	Scale per inch
¼″	1/48	1/48″	2″	1/6	1/6″
½″	1/24	1/24″	3″	1/4	1/4″
¾″	1/16	1/16″	4″	1/3	1/3″
1″	1/12	1/12″	6″	1/2	1/2″
1½″	1/8	1/8″	9″	3/4	3/4″

12″ to the foot is full size.

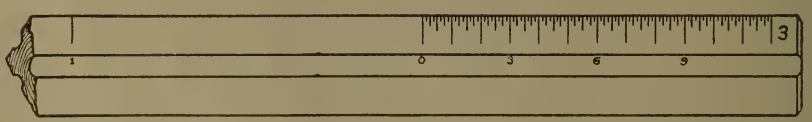


Figure 9

Referring to the 3″ scale marked 3 on the architect's scale, Fig. 9, it is found that the 3″ space has been divided into twelve equal parts representing inches, every third one of which has been marked 3, 6, 9.

The divisions representing inches are subdivided to indicate ½", ¼" and ⅛". To use the scale, from the zero point find the number of inches reading to the right and using the figures 3, 6, and 9 to aid in the reading. 5" is found, two of the inch divisions to the right of the division marked 3, reading from the zero; 2½" is two and one-half divisions to the right of the zero point. 1 FT 7" is found by reading to left from zero to the longer division marked 1 in the groove and to the right from zero to the seven inch division. The other scales are similarly divided and similarly used.

Dividers:—This instrument consists of two pointed legs jointed at the top so as to be adjustable for any desired size. The dividers are used to transfer equal distances from one part of the drawing to another and to measure off several equal distances along a line. In doing this, care should be taken not to press too heavily on the points, as this makes a large hole in the paper or possibly bends and even breaks the steel points. This may be avoided by first turning the dividers for the succeeding distance and then pressing down just sufficiently to give a mark that may be seen readily.

Compasses:—These are very much like the dividers just described except that one leg has an adjustable steel point. This steel point has a shoulder to prevent the fine needle point from wearing a large hole in the paper. The other leg of the compass is provided with a pencil attachment as well as a pen point to draw circles in ink. An extension-bar is also provided for adjustment in drawing large circles. Only a slight pressure should be given the steel point to avoid wearing a large hole.

Ruling Pen:—The ruling pen has two blades. The distance apart of the points or nibs is adjusted by means of a little set screw. This adjustment determines the width of the line. The right line pen needs especial attention as it is used perhaps more than any other instrument. It must be well taken care of and thoroughly cleaned. Ink must not be allowed to dry on the points as this will corrode and ruin the pen. The adjustment, manner of holding and using the pen will be taken up in a chapter by itself later.

Precautions to insure neatness:—In order to keep the drawing clean, it will be quite necessary to wipe the dust off the triangles and T-square with a clean cloth. Brush or wipe off the drawing each time. Brush the particles of rubber away after erasing. In the case of a large drawing, the finished portion may be kept covered.

Arrrangement:—Place the drawing or drawings so that the sheets appear well balanced as a whole. The notes and titles should be placed where they may be conveniently read and so that

they add to the appearance of the drawing. Notes whenever possible are to be placed in a horizontal line, seldom in a vertical line. All figures and notes must be read from the bottom or from the right-hand side of the drawing.

Rapid Drafting:—By following a few little pointers a draftsman may accomplish more than he otherwise would. After the border line and title are laid out, block out the arrangement first. Get the location and general outline first, drawing in the details afterwards, thus building up the drawing. It is often well to put on the dimensions as the drawing proceeds. While the T-square is in hand draw all the horizontal lines possible; all vertical and oblique lines while the triangles are in use. Proceed in like manner with each instrument. In inking, draw all lines of the same width with one setting of the pen. Do all the lettering at one time. Repeating useless motions hinders. A definite order of doing things cannot be too strongly emphasized.

INKING

F. R. Kepler

Having completed the pencil drawing, the student should next put his ruling or right line pen in working order, adjust and mark the little thumb screw for the different width of lines; fine, medium and heavy.

Preliminary Practice:—It is well for the student using a ruling pen for the first time, to draw a number of lines on a loose sheet of paper with the triangles as guides, until he is able to draw them straight. At first thought this may seem easy; however, the drawing of a straight line requires much practice.

Manner of Holding and Using the Ruling Pen:—(1) In drawing lines with a right line pen, see that both blades bear with equal force upon the paper. (2) The pen should be inclined slightly in the direction of motion. Only pressure enough to guide it should be given against the straight edge, otherwise the blades will be forced together and a line of unequal width will result. (3) The lines are drawn by moving the pen from left to right, keeping it parallel to the first position, for if it is moved away from or toward the body while tracing a line, the point of the pen will become closer or farther away from the guiding edge and the line will be wavy. (4) To lessen the danger of blotting, the guiding edge should be slightly removed from the line to be drawn so that the pen point in tracing the line will not come in contact with it.

Manner of Using the Compass:—(1) As with the ruling pen, the blades of the compass must bear evenly upon the paper. To attain this, the compass legs will have to be adjusted in the joints so that they will be perpendicular to the paper. (2) In describing arcs, allow only the weight of the compass to bear upon the needle point, as greater pressure will cause the point to wear a hole in the paper. A slight pressure may be given to the pen point, however. (3) The top of the compass should be but slightly inclined in the direction of the motion.

Hints for Inking in a Drawing:—(1) Draw all lines of the same width with one setting of the pen to insure uniform width of line throughout the drawing. (2) When several lines radiate from a point, the lines should be drawn from the point, not toward it, allowing each line to dry before drawing the next one in order to prevent a blot which is very likely to be made at the point. (3) Since it is easier to make a straight line meet a curve than otherwise, do the compass work first, then the straight lines. (4) In erasing ink lines, the best draftsmen use the steel eraser first. Afterward a good, clean rubber. A clean, hard, smooth substance is then used to make the paper smooth again and thus prevent the ink from spreading. Use a clean cloth or brush to remove the particles of rubber. (5) The student should always strive to be neat and should keep covered that portion of the drawing which he is not working upon at the time.

ORDER OF INKING IN

Group I. Object lines—Medium lines.
1. Circles and arcs of circles.
2. Irregular curves.
3. Horizontal lines; begin at top.
4. Vertical lines; begin at the left.
5. Oblique lines.

Group II. Center, witness, and dimension lines—Fine hair lines. Use same order as in Group I.

Group III. Dimensions and arrow heads. Notes. Title.

Group IV. Section lines—Fine lines at 45 degrees.

Group V. Border lines—Heavy lines.

TRACING

It is often desirable to make a more permanent and serviceable record of a drawing than would be possible if only the inked original drawing were used. To accomplish this a tracing of the penciled drawing is made on tracing cloth. From this tracing as many blue-prints as desirable may be made—these are durable, since they will withstand the wear and the danger of erasure from the weather and hard usage.

The tracing cloth should be cut somewhat larger than the drawing, so that the thumb-tack holes may be removed when the tracing is trimmed to the proper size. This can readily be done, since 36″ cloth actually measures 37″ wide, being 36″ wide between the red lines near the edge.

Tack the cloth down to the board so that it will be tight and free from wrinkles, as the tracing may be done more rapidly. The cloth should have no creases or breaks in it from ill usage. Either the dull or the glossy side of the cloth may be used. A great many prefer and use the dull side because in the drafting room corrections in pencil may more readily be made on this side than on the glossy side.

Dust the surface over with chalk, magnesia or talcum powder. Rub this lightly into the surface and brush all the loose particles off thoroughly to rid the surface of grease and grit and to insure a ready flow of the ink.

In order to maintain a uniform width of line throughout keep the same amount of ink in the pen, about a quarter of an inch at the most. Keep the pen clean. It will be necessary to clean the pen often, as little particles of chalk will be picked up which interfere with the even flow of the ink. If it is impossible to complete the whole tracing at one sitting finish one part, including circles, straight lines, medium and fine. This is most desirable, as the cloth is liable to stretch during the intervening time between sittings, making it difficult to readjust the tracing to the drawing.

Erasing—Use an ordinary eraser in erasing. Never use one with sand in it. Never use a steel eraser. These either destroy the surface of the cloth, making it impossible to retrace, or a hole is cut in the cloth, ruining the whole tracing. After erasing it is often necessary to build up from a fine line to one of full weight.

WORKING DRAWINGS

A working drawing of a piece must have at least two views; more complicated pieces require three or even more views. The top view, or plan, shows a piece as it would be seen looking directly down on top of the part from above. The front view, or elevation, shows the piece as would be seen looking at the part from a point in front and directly on a level with the eye.

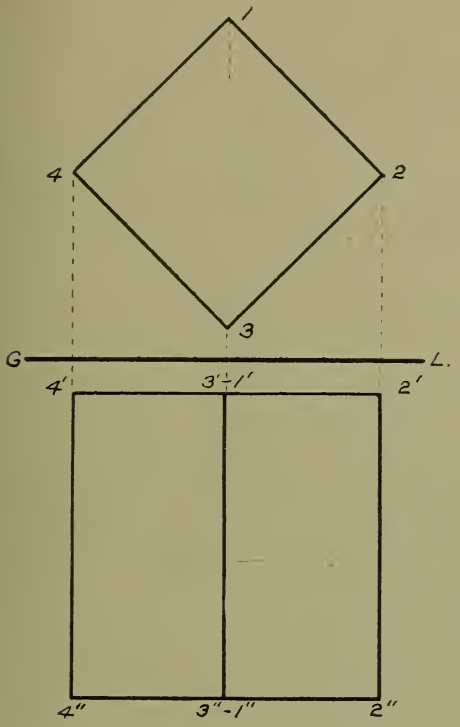


Figure 10

If a piece of paper be folded so as to form the top of a box and the upright part the front of the box, we can imagine that the top view of an object appears on the level portion of the folded paper, while the front view appears on the upright position of the paper. By unfolding the paper into the same level it is divided into two portions by the crease along which it was folded.

This crease may represent a line called the **Ground Line** (**G. L**). This line is convenient in locating the drawings on the sheet and in explanations.

The top view is always placed above the **Ground Line** (**G. L**). and the front view is always placed directly below it, in the same vertical line. It is evident that the top view of a part and the front view are of the same width. Suppose that the square **1, 2, 3, 4,** Fig. 10, is the top view of a square prism with the sides 45 degrees to **G. L.**

By placing the triangle against the tee-square, draw the vertical line **4, 4″,** the portion **4′, 4″** of the line represents the left-hand edge of the prism. In like manner draw the line **3, 3″** to locate the front edge, and **2, 2″** to locate the right-hand edge of the prism. Draw the horizontal line **4″, 2″** to show the base, for all the corners of the base appear in the same straight line when the base is on a level with the eye. Measure off the height and draw the horizontal line **4′, 2′** to show the upper

base. It will be observed that the top view and front view of any point are in the same straight line perpendicular to the **Ground Line**

Fig. 11 shows the drawing of a piece requiring three views. The making of the top and the front views is the same as that already described. Again, folding a piece of paper around the right-hand end of a box, we may imagine that we have the right-hand end view of the piece on this portion of the paper. Unfolding the paper out straight with the front of the box, it is observed that the end view comes at the right of the front view in the same horizontal line and is of the same height.

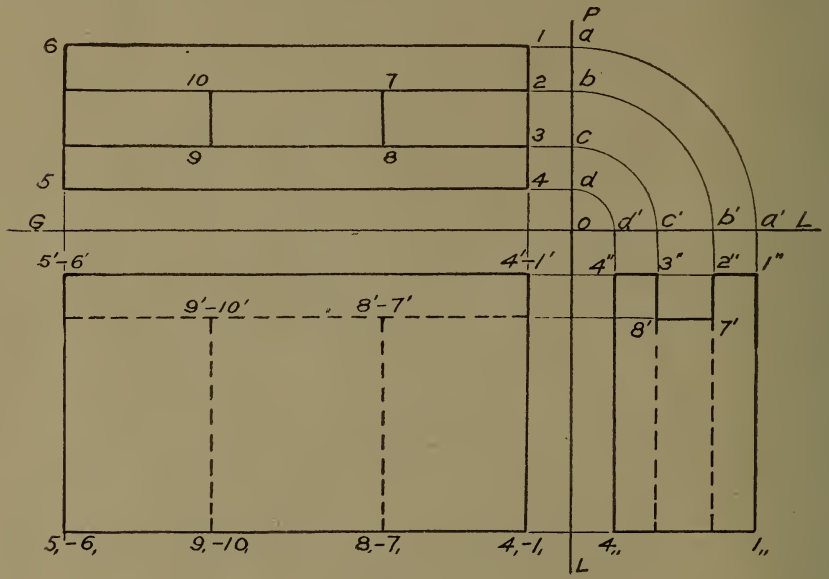


Figure 11

The fold, or crease, in the paper represents the front right-hand edge of the box. This is called the **Profile Line** (**P. L**). Having made the top and front views, to obtain the end view project the horizontal lines from **1** to **a**, **4** to **d**, on the **P. L.**; where the **P. L.** and the **G. L.** cross, or intersect, at **o** as a center and a radius **oa** draw one fourth of the arc of a circle until it meets **G. L.** at **a′**. In like manner with **od** as a radius draw the arc to **d′**. Draw the vertical lines **a′—1,,** and **d′—4,,** with the tee-square and triangle. Project the horizontal lines from **1′** to **1″** and **1,** to **1,,** thus getting the height of the end view. Observe that the back corner **1** in the top view comes at the right at **1″** in the end view. The width and depth of the groove are found similarly to the outside edges. Also observe that the location of the hidden edges, or parts, are shown with short $\frac{1}{8}''$ dashes.

LIBRARY OF CONGRESS
0 019 934 550 3

LIBRARY OF CONGRESS
0 019 934 550 3